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C.2

January 2000



Biology 30
Grade 12 Diploma Examination

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January 2000

Biology 30

Grade 12 Diploma Examination

Description

Time: This examination was developed to be completed in 2.5 h; however, you may take an additional 0.5 h to complete the examination.

This is a **closed-book** examination consisting of

- 48 multiple-choice and 8 numerical-response questions, of equal value, worth 70% of the examination
- 2 written-response questions, of equal value, worth 30% of the examination

This exam contains sets of related questions.

A set of questions may contain multiple-choice and/or numerical-response and/or written-response questions.

Tear-out data pages are included near the back of this booklet.

Note: *The perforated pages at the back of this booklet may be torn out and used for your rough work. No marks will be given for work done on the tear-out pages.*

Instructions

- You are expected to provide your own scientific calculator.
- Use only an HB pencil for the machine-scored answer sheet.
- Fill in the information required on the answer sheet and the examination booklet as directed by the presiding examiner.
- Read each question carefully.
- Consider all numbers used in the examination to be the result of a measurement or observation.
- If you wish to change an answer, erase **all** traces of your first answer.
- Do not fold the answer sheet.
- The presiding examiner will collect your answer sheet and examination booklet and send them to Alberta Learning.
- Now turn this page and read the detailed instructions for answering machine-scored and written-response questions.

Multiple Choice

- Decide which of the choices **best** completes the statement or answers the question.
- Locate that question number on the separate answer sheet provided and fill in the circle that corresponds to your choice.

Example

This examination is for the subject of

- A. biology
- B. physics
- C. science
- D. chemistry

Answer Sheet



Numerical Response

- Record your answer on the answer sheet provided by writing it in the boxes and then filling in the corresponding circles.
- If an answer is a value between 0 and 1 (e.g., 0.25), then be sure to record the 0 before the decimal place.
- Enter the first digit of your answer in the left-hand box and leave any unused boxes blank.**

Examples

Calculation Question and Solution

The average of the values 21.0, 25.5, and 24.5 is _____.

(Round and record your **answer to one decimal place** in the numerical-response section on the answer sheet.)

$$\begin{aligned}
 \text{Average} &= (21.0 + 25.5 + 24.5)/3 \\
 &= 23.666... \\
 &= 23.7 \text{ (rounded to one decimal place)}
 \end{aligned}$$

Record 23.7 on the answer sheet →

2	3	.	7
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<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>
<input type="radio"/> 0	<input type="radio"/> 0	<input type="radio"/> 0	<input type="radio"/> 0
<input type="radio"/> 1	<input type="radio"/> 1	<input type="radio"/> 1	<input type="radio"/> 1
<input checked="" type="radio"/> 2	<input type="radio"/> 2	<input type="radio"/> 2	<input type="radio"/> 2
<input type="radio"/> 3	<input checked="" type="radio"/> 3	<input type="radio"/> 3	<input type="radio"/> 3
<input type="radio"/> 4	<input type="radio"/> 4	<input type="radio"/> 4	<input type="radio"/> 4
<input type="radio"/> 5	<input type="radio"/> 5	<input type="radio"/> 5	<input type="radio"/> 5
<input type="radio"/> 6	<input type="radio"/> 6	<input type="radio"/> 6	<input type="radio"/> 6
<input type="radio"/> 7	<input type="radio"/> 7	<input type="radio"/> 7	<input checked="" type="radio"/> 7
<input type="radio"/> 8	<input type="radio"/> 8	<input type="radio"/> 8	<input type="radio"/> 8
<input type="radio"/> 9	<input type="radio"/> 9	<input type="radio"/> 9	<input type="radio"/> 9

Correct-Order Question and Solution

When the following subjects are arranged in alphabetical order, the order is _____.

(Record your **four-digit answer** in the numerical-response section on the answer sheet.)

- 1 physics
- 2 chemistry
- 3 biology
- 4 science

Answer 3214

Record 3214 on the answer sheet

→

3	2	1	4
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•	•		
0	0	0	0
1	1	●	1
2	●	2	2
●	3	3	3
4	4	4	●
5	5	5	5
6	6	6	6
7	7	7	7
8	8	8	8
9	9	9	9

Selection Question and Solution

The birds in the following list are numbered _____.

(Record your answer **in lowest-to-highest numerical order** in the numerical-response section on the answer sheet.)

- 1 dog
- 2 sparrow
- 3 cat
- 4 robin
- 5 chicken

Answer 245

Record 245 on the answer sheet

→

2	4	5	
---	---	---	--

•	•		
0	0	0	0
1	1	1	1
●	2	2	2
3	3	3	3
4	●	4	4
5	5	●	5
6	6	6	6
7	7	7	7
8	8	8	8
9	9	9	9

Written Response

- Write your answers in the examination booklet as neatly as possible.
- For full marks, your answers must address **all** aspects of the question.
- Descriptions and/or explanations of concepts must be correct and include pertinent ideas, diagrams, calculations, and formulas.
- Your answers must be presented in a well-organized manner using complete sentences, correct units, and significant digits where appropriate.
- Relevant scientific, technological, and/or societal concepts and examples must be identified and made explicit.

Additional Instructions for Students Using Word Processors

- Keep all work together. Diagrams, graphs, calculations, etc. should be placed directly on your word-processed pages.
- Staple your final printed work to the page indicated for each word-processed response.
- Indicate in the space provided on the back cover that you attached word-processed pages.



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Use the following information to answer the first two questions.

A group of psychologists wondered if inhaling pure oxygen could enhance a person's mental capacity. They tested forty-five students.

These students breathed through a face mask for one minute. They were either given pure oxygen or normal air, but they did not know which. Those receiving pure oxygen could recall twice as many words as those receiving normal air.

—from *Mihill, 1996*

1. The part of the brain that is directly responsible for the recall of previously learned words is the
 - A. cerebrum
 - B. cerebellum
 - C. pituitary gland
 - D. medulla oblongata

2. The part of the brain that controls the unconscious rate of breathing is the
 - A. cerebrum
 - B. cerebellum
 - C. pituitary gland
 - D. medulla oblongata

Use the following information to answer the next two questions.

Movement of hair cells in normal ears opens tiny pores called ion channels in the nerve cell membrane. This process begins impulse transmission along the auditory nerve.

3. Nerve impulse transmission continues along the nerve cell membrane as
- A. a wave of depolarization
 - B. a negative feedback loop
 - C. a diffusing wave of summation
 - D. the active transport of an electrical potential
4. The part of the ear **directly** responsible for stimulating the nerve endings that transmit sound impulses from the ear to the brain is the
- A. cochlea
 - B. eardrum
 - C. Eustachian tube
 - D. semicircular canal

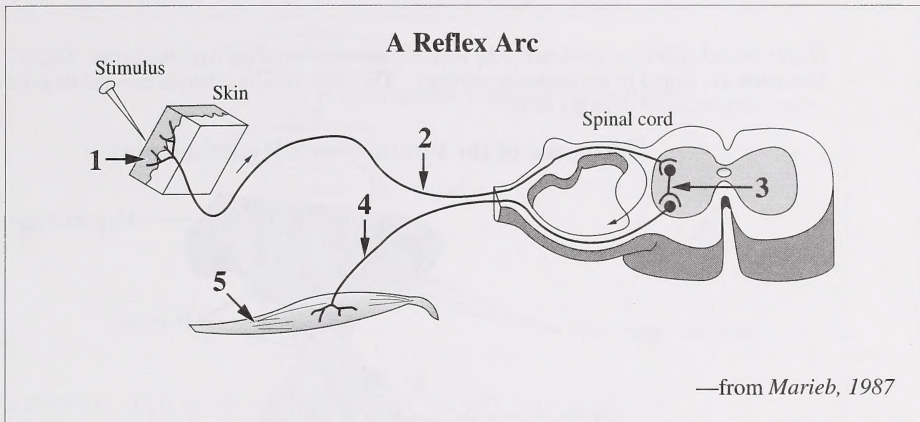
Use the following information to answer the next two questions.

Many predatory birds such as eagles have two foveas in each eye. The fovea in predatory birds is similar in structure and function to the fovea in humans. In addition, these birds have strong powers of near and far accommodation.

—from *Curtis, 1983*

5. If an eagle's brain were similar in structure to a human brain, impulses that begin in the retina of the eagle's eye would travel first to the
- A. frontal lobe
 - B. parietal lobe
 - C. occipital lobe
 - D. temporal lobe
6. Strong near and far accommodation in the eye require
- A. small blind spots
 - B. a large number of rods
 - C. a large number of cones
 - D. highly developed ciliary muscles

Use the following diagram to answer the next question.



Numerical Response

1. Identify the structure, as numbered above, that performs each of the functions given below.

Structure: _____

Function: Transmits impulses
to the central
nervous system

Receives sensory
stimulation

Carries out
instructions from
the central nervous
system; is a
muscle

Transmits impulses
from the central
nervous system to
the effector

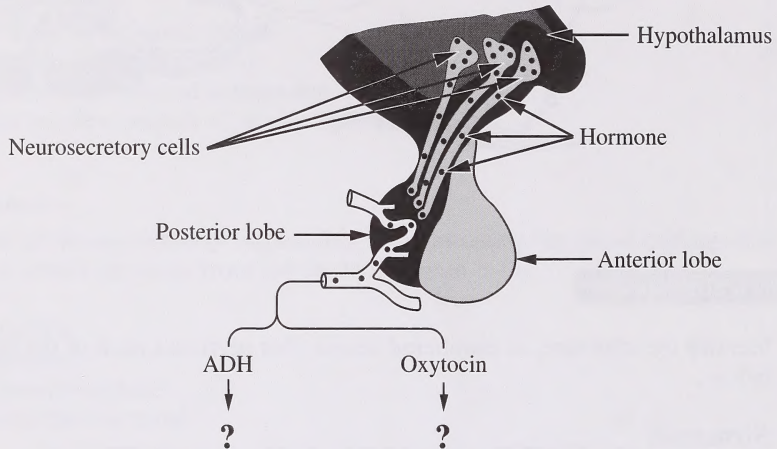
(Record your **four-digit answer** in the numerical-response section on the answer sheet.)

7. Jogging will cause heart rate to change because of
- increased sympathetic and decreased parasympathetic impulses
 - decreased sympathetic and increased parasympathetic impulses
 - increased sympathetic and decreased central nervous system impulses
 - decreased sympathetic and increased central nervous system impulses
8. Damage to which of the following endocrine glands would **most affect** the reaction of the body to an emergency that stimulates the sympathetic nervous system?
- Thyroid gland
 - Adrenal gland
 - Anterior pituitary gland
 - Posterior pituitary gland

Use the following information to answer the next question.

Oxytocin and ADH are synthesized by neurosecretory cells in the hypothalamus. These hormones are stored in the posterior pituitary. They can then be released into the bloodstream where they circulate to target cells.

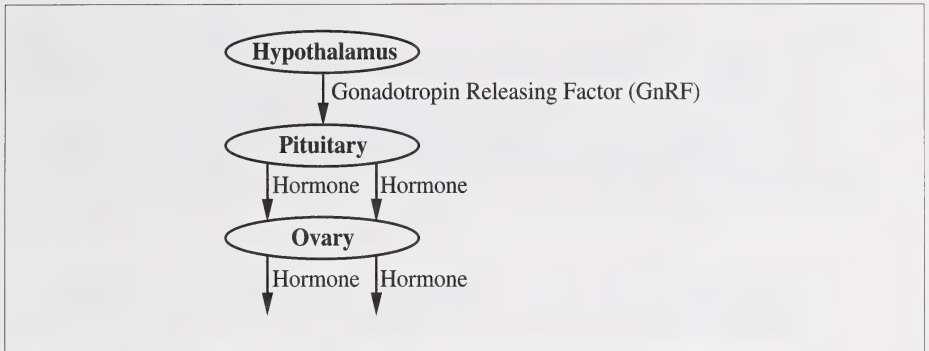
Hormones of the Pituitary and Hypothalamus



—from Campbell, 1987

9. In a human female, where are the target cells for ADH and oxytocin?
- A. In the kidney tubules and ovaries
 - B. In the Bowman's capsule and the ovaries
 - C. In the kidney tubules and uterine muscles
 - D. In the Bowman's capsule and the uterine muscles

Use the following information to answer the next question.



10. In humans, high levels of GnRF cause the pituitary to release

- A. LH and FSH
- B. LH and estrogen
- C. progesterone and FSH
- D. estrogen and progesterone

Use the following information to answer the next question.

Responses Stimulated by Hormones

- | | |
|------------------------------------|--------------------------------------------------|
| 1 Release of thyroxine | 4 Development of follicle and sperm |
| 2 Development of bones and muscles | 5 Ovulation and maintenance of the corpus luteum |
| 3 Water reabsorption by kidneys | 6 Milk production |

Numerical Response

2. Identify the response, as numbered above, that would be stimulated by each of the hormones given below.

Response: _____
Hormone: STH(HGH) LH TSH FSH

(Record your **four-digit answer** in the numerical-response section on the answer sheet.)

Use the following information to answer the next five questions.

The spermicide nonoxynol-9, which is applied to contraceptive devices such as diaphragms and condoms, has been linked to increased urinary tract infections in women. Although nonoxynol-9 is helpful in fighting the herpes virus and HIV, it also destroys beneficial bacteria (lactobacilli) that moderate the acidity of a woman's vagina. As a woman's vagina and external genitalia become more acidic, another bacterium, *Escherichia coli* (*E. coli*), increases in number and invades her urethra. This overpopulation of *E. coli* causes a bladder infection.

—from Vergano, 1996

11. The relationships described above between the human female, lactobacilli, and *E. coli* are identified in row

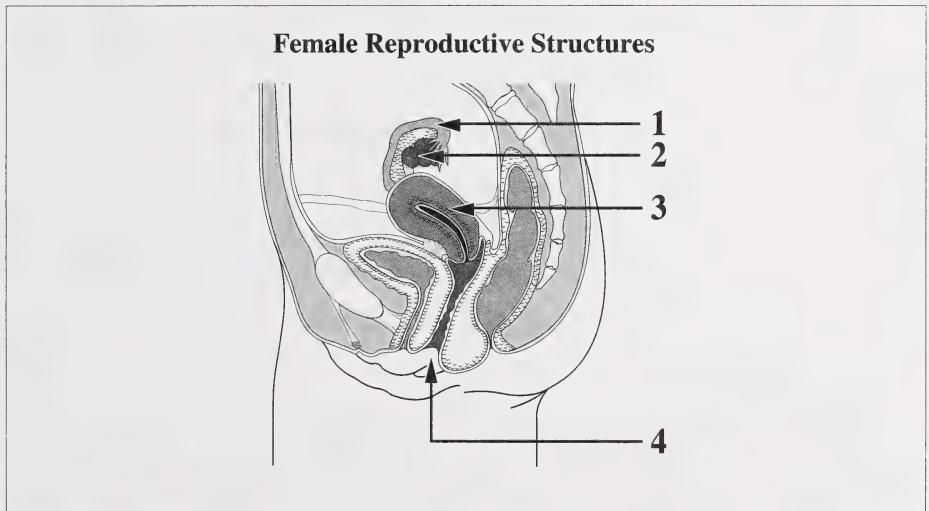
Row	Human female/lactobacilli	Human female/ <i>E. coli</i>	Lactobacilli/ <i>E. coli</i>
A	parasitic	mutualistic	interspecific competition
B	mutualistic	mutualistic	intraspecific competition
C	mutualistic	parasitic	interspecific competition
D	parasitic	parasitic	intraspecific competition

12. The site of sperm production and the gland that produces an alkaline secretion that neutralizes the acidity of the vagina are given in row

Row	Site of Sperm Production	Gland that Produces an Alkaline Secretion
A	seminiferous tubules	testis
B	seminiferous tubules	prostate gland
C	seminal vesicles	testis
D	seminal vesicles	prostate gland

13. Testes are responsible for the production of sperm and testosterone. Cutting and tying the vas deferens (vasectomy) blocks the passage of sperm. After a vasectomy, the hormone testosterone
- A. reaches all the body tissues because it comes from exocrine tissue
 - B. reaches all the body tissues because it comes from endocrine tissue
 - C. does not reach all the body tissues because it comes from exocrine tissue
 - D. does not reach all the body tissues because it comes from endocrine tissue

Use the following additional information to answer the next question.

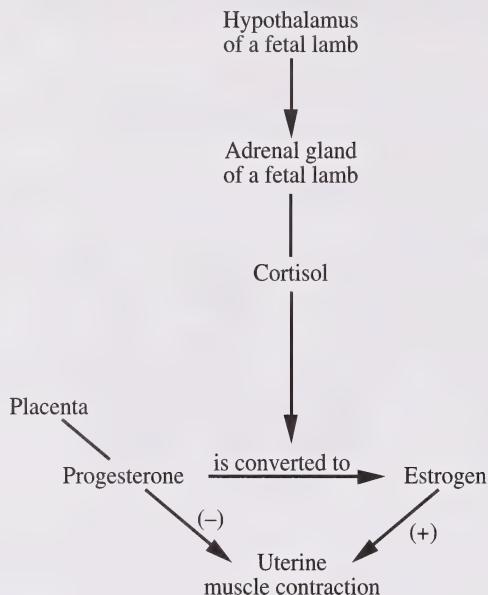


14. Some contraceptives, such as condoms, prevent fertilization. Fertilization usually occurs in the structure labelled
- A. 1
 - B. 2
 - C. 3
 - D. 4
15. Another contraceptive, the birth control pill, causes negative feedback on the pituitary, which prevents the release of eggs. Typically, the hormones in the birth control pill are similar to
- A. FSH and LH
 - B. oxytocin and prolactin
 - C. estrogen and progesterone
 - D. relaxin and gonadotropins

Use the following information to answer the next four questions.

Research on sheep might explain what stimulates pregnant mammals, including humans, to give birth. Through research on pregnant sheep, scientists have developed the following scheme to explain normal events as birth begins.

Influence of Fetal Hormones on the Maternal Reproductive System



Note: The placenta produces progesterone throughout the pregnancy, but activation of the fetal hypothalamus only occurs as birth begins.

—from *Discover*, 1992

16. According to this diagram, the birth of a lamb is linked to
- A. increasing levels of estrogen in pregnant sheep
 - B. decreasing production of cortisol by the fetal lamb
 - C. increasing levels of progesterone in pregnant sheep
 - D. decreasing activity of the hypothalamus by the fetal lamb
17. To maintain a pregnancy for a normal gestation period, the contraction of uterine muscles is inhibited. According to the diagram, this inhibition is brought about by
- A. high levels of estrogen from the placenta
 - B. low levels of progesterone from the uterus
 - C. high levels of cortisol from the adrenal gland
 - D. high levels of progesterone from the placenta

18. Which of the following statements concerning human reproduction is supported by the findings of this research?
- A. Developments within the fetus determine when birth will begin.
 - B. The production of fetal cortisol delays birth until gestation is complete.
 - C. During early fetal development, fetal hormones do not pass into the mother.
 - D. High levels of progesterone in the mother's blood are essential for birth to begin.

Use the following additional information to answer the next question.

Ingestion of a plant called skunk cabbage by pregnant sheep has been found to cause severe birth defects and to delay birth for several weeks.

19. A reasonable hypothesis is that skunk cabbage contains a chemical that
- A. increases uterine sensitivity to estrogen
 - B. decreases placental production of progesterone
 - C. inhibits the fetal hypothalamus or adrenal gland
 - D. increases conversion of progesterone to estrogen
-
20. Cryptorchidism is the failure of one or both of the testes to descend from the abdominal cavity into the scrotum during human fetal development. Sterility results if both testes fail to descend. In this case, the likely cause of sterility is that
- A. lack of oxygen inhibits testosterone function
 - B. gonadotropic hormones cannot stimulate the testes
 - C. the testes are not connected to the external environment
 - D. normal sperm do not readily develop at body temperature

Use the following information to answer the next two questions.

Yaws, bejel, and syphilis are three diseases known to be caused by strains of bacteria in the genus *Treponema*. Syphilis is a sexually transmitted disease, whereas yaws and bejel are not sexually transmitted. Studies of 800-year-old to 1 600-year-old skeletons from Florida, Ecuador, and New Mexico show that these people suffered from syphilis. Studies on 6 000-year-old skeletons from Illinois, Virginia, and Ohio show that these people suffered from yaws.

—from Zabludoff, 1996

21. Which of the following conclusions can be made about these related diseases?
- A. A person can easily contract syphilis in warm climates.
 - B. The syphilis strain of *Treponema* may have mutated from the yaws strain.
 - C. Non-sexually transmitted diseases have developed from sexually transmitted diseases.
 - D. Older people tend to suffer from yaws, and younger victims develop syphilis when exposed to *Treponema*.

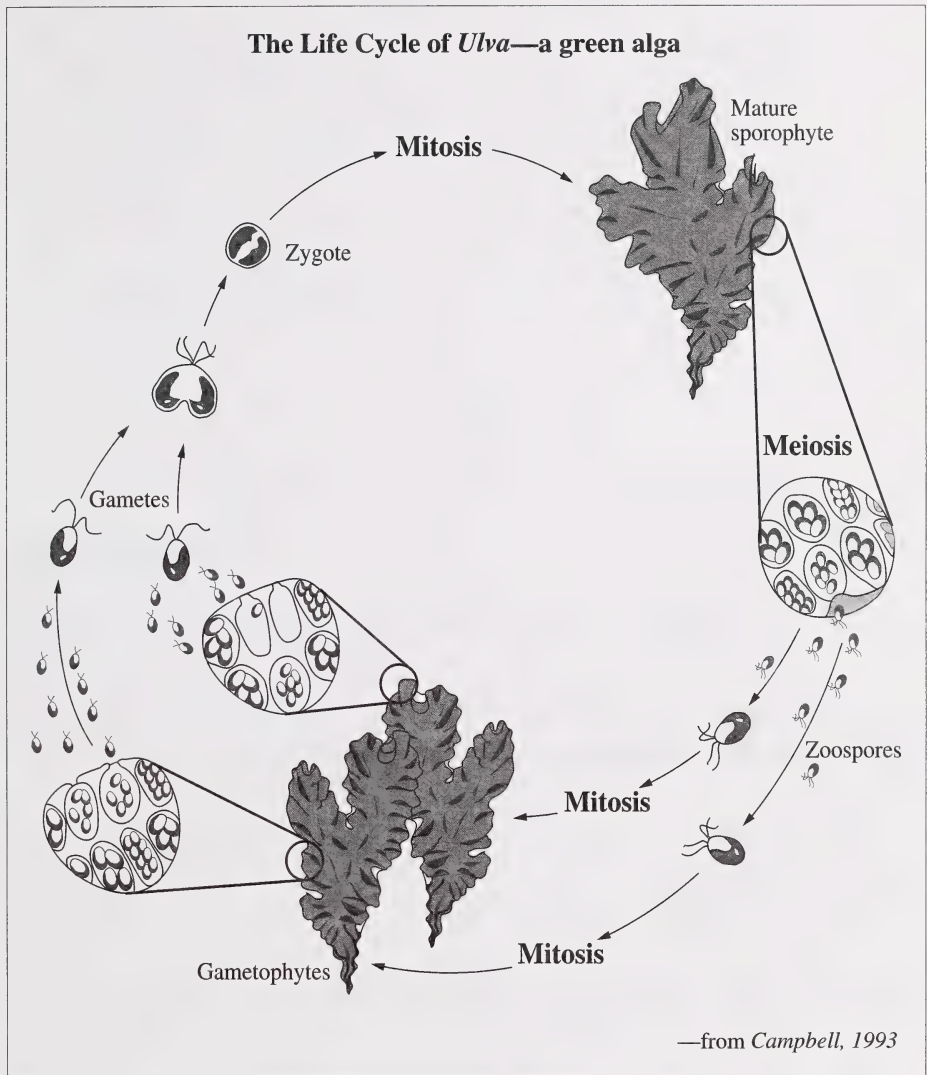
Use the following additional information to answer the next question.

The symptoms of untreated syphilis usually disappear within 12 weeks of the initial infection. However, new symptoms may appear many years later. These include damage to neurons of the central nervous system.

—from Zabludoff, 1996

22. The neurons damaged by syphilis are
- A. interneurons
 - B. sensory neurons
 - C. somatic motor neurons
 - D. autonomic motor neurons

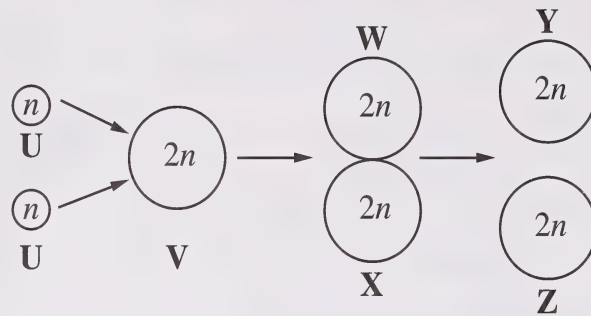
Use the following information to answer the next question.



23. Which structures in the life cycle of the *Ulva* are haploid (monoploid)?
- A. Zoospores and the zygote
 - B. The sporophyte and the zygote
 - C. Zoospores and the gametophytes
 - D. The sporophyte and the gametophytes

Use the following information to answer the next four questions.

Chromosome Content of Human Cells During a Series of Events



24. In humans, what process must have occurred to obtain the cells at **U**?
- A. Mitosis
 - B. Meiosis
 - C. Fertilization
 - D. Differentiation
25. In humans, what process occurs between **U** and **V**?
- A. Mitosis
 - B. Meiosis
 - C. Fertilization
 - D. Differentiation
26. In humans, what process must occur before cell **V** forms cells **W** and **X**?
- A. Mitosis
 - B. Meiosis
 - C. Recombination
 - D. Nondisjunction

27. In humans, cells **Y** and **Z** represent individual cells that

- A. are two eggs
 - B. will no longer divide
 - C. will become a $4n$ cell
 - D. could develop into identical twins
-

Use the following information to answer the next question.

Phases of Mitosis

- 1 Anaphase
- 2 Metaphase
- 3 Prophase
- 4 Telophase

Numerical Response

3. The phases of mitosis in the sequence in which they occur are _____, _____, _____, and _____.

(Record your **four-digit answer** in the numerical-response section on the answer sheet.)

Use the following information to answer the next four questions.

The flowering plant, *Mirabilis jalapa* (*M. jalapa*) may have branches with all white leaves, all green leaves, and all variegated leaves (leaves with green and white patches) on the same plant. Leaf colour is dependent on the colour of plastids present in cytoplasm. As in the case of other plants, pollen (containing sperm nuclei) contribute chromosomes but almost no cytoplasm to the zygote. The ovule contributes both chromosomes and cytoplasm to the zygote. The following data of offspring phenotypes were collected from crosses between flowers from various branches.

Source of pollen (male)	Source of ovule (female)	
	White branch	Green branch
White branch	White offspring	Green offspring
Green branch	White offspring	Green offspring
Variegated branch	White offspring	Green offspring

—from Griffiths, 1993

28. These data indicate that, regardless of its branch source, pollen has no effect on the leaf colour of resulting offspring. A reasonable explanation for this observation is that
- leaf colour is a codominant trait
 - leaf colour is a dominant–recessive trait
 - cell organelles or cytoplasm are active only in pollen
 - cell organelles or cytoplasm contain genetic information

Use the following additional information to answer the next question.

Several geneticists studied *M. jalapa* plants with deep crimson flowers and *M. jalapa* plants with yellow flowers. Cross-pollinating these plants produced plants with scarlet-red flowers (F_1 generation).

These F_1 plants were allowed to self-pollinate, and the resulting seeds produced *M. jalapa* plants with three different flower colours. Data similar to the following were collected for flower colour:

140 deep crimson
310 scarlet-red
160 yellow

—from Engels, 1975

29. With respect to the alleles for flower colour, these results indicate
- X-linked inheritance
 - gene-linked inheritance
 - dominant-recessive inheritance
 - incomplete dominance inheritance

Use the following additional information to answer the next two questions.

A different variety of homozygous *M. jalapa* produces flowers that are light crimson. Pure-breeding genotypes and phenotypes are:

$R^P R^P$ – deep crimson

RR – light crimson

rr – yellow

When two pure-breeding P_1 plants are cross-pollinated, only scarlet-red-flowered offspring ($R^P r$) are produced.

When another pair of pure-breeding P_1 plants are cross-pollinated, only orange-flowered offspring (Rr) are produced.

—from *Engels, 1975*

30. The likely genotypes of the P_1 plants for these two crosses is represented in row

Row	P_1 genotypes scarlet-red-flowered offspring	P_1 genotypes orange-flowered offspring
A	$R^P R \times rr$	$RR \times rr$
B	$R^P R^P \times rr$	$RR \times rr$
C	$R^P r \times R^P r$	$Rr \times Rr$
D	$R^P R^P \times RR$	$R^P R \times Rr$

31. Which of the following phenotypes is the predicted flower colour of *M. jalapa* with the genotype $R^P R$?
- A. Yellow
 - B. Orange
 - C. Crimson
 - D. Scarlet-red

Use the following information to answer the next two questions.

Feather colour in parakeets is controlled by two genes. For one pigment gene, the B allele produces blue colour and the b allele does not produce any colour. For the other pigment gene, the Y allele produces yellow colour and the y allele does not produce any colour. Any genotype containing at least one B allele and one Y allele will produce a green parakeet.

32. Which of the following parental genotypes could produce offspring with the **four** different colour patterns?
- A. $BBYy \times BbYy$
 - B. $BbYY \times Bbyy$
 - C. $bbYY \times bbyy$
 - D. $Bbyy \times bbYy$
33. What is the probability of obtaining a blue parakeet when two green heterozygous parakeets are crossed?
- A. 0
 - B. $\frac{3}{16}$
 - C. $\frac{1}{4}$
 - D. $\frac{9}{16}$



Parakeet

—from Macrich, 1998

Use the following information to answer the next question.

A community of Pima Indians in the American Southwest has a very high rate of diabetes in their adult population. Of the population of adults over the age of 35, 42% to 66% develop diabetes. The recessive trait that causes diabetes in this population is a distinct disadvantage to individuals whose diets are rich in carbohydrates.

—from *Cummings*, 1993

Numerical Response

- 4.** If 42% of the population have diabetes, then the percentage of the population who are carriers is calculated to be _____%.

(Record your **answer as a whole number** in the numerical-response section on the answer sheet.)

Use the following information to answer the next question.

Portion of the Insulin Protein

Phenylalanine – Valine – Asparagine – Glutamate – Histidine

Assume that a mutation occurred in the strand of DNA that codes for the portion of protein shown above. The protein was altered in structure and no longer performed its function.

—from *Campbell*, 1987

- 34.** Which of the following effects would this mutation have on an individual's body?
- A.** A chronic increase in blood sugar after meals
 - B.** A chronic decrease in blood sugar after meals
 - C.** A decrease in the body's metabolic rate after meals
 - D.** An increase in the body's metabolic rate after meals

Use the following information to answer the next question.

Erwin Chargaff found that the relative amount of each of the base pairs that make up DNA varies from species to species. He analyzed a sample of DNA from *Escherichia coli* (a bacterium) and found that 23.6% of the nitrogen base molecules present in this sample were thymine.

—from Curtis, 1983

35. In this sample of *Escherichia coli* DNA, the percentage of the nitrogen base molecules that would be adenine is
- A. 76.4%
 - B. 38.2%
 - C. 23.6%
 - D. 11.8%

Use the following information to answer the next two questions.

A condition called “situs inversus” causes the internal organs of an animal to be reversed and end up on the wrong side of the body. Researchers have shown that insertion of a DNA fragment in one particular structural gene of mice may lead to this condition. Mice homozygous for this insertion are born with their organs reversed and die within a week of their birth. Mice heterozygous for this insertion are born with their organs in normal positions.

—from Oliwenstein, 1993

36. Which of the following statements is a **reasonable** conclusion based on this information?
- A. The gene with the inserted DNA fragment is recessive.
 - B. The gene with the inserted DNA fragment is dominant.
 - C. The affected gene produces a protein that influences embryonic development.
 - D. The affected gene cannot be transcribed after foreign DNA has been inserted.
37. If two heterozygous mice were mated, what percentage of their offspring would be predicted to die?
- A. 0%
 - B. 25%
 - C. 50%
 - D. 75%

Use the following information to answer the next two questions.

Although most strains of the bacterial species *Vibrio cholera* are harmless, the 01 strain produces a toxin that binds to cells of the small intestine, causing rapid depletion of salts and water, which, if not replaced, can be lethal in humans. This disease is known as cholera.

The transformation from harmless to harmful bacterial strains is thought to be caused by a virus that transfers the cholera toxin gene (CTX) from one bacterial strain and places it into another. Researchers can mimic this process by using current technologies.

—from *Glausiusz*, 1996

38. The sequence of events that would enable researchers to incorporate the CTX gene into bacterial DNA would be to
- A. first open the bacterial DNA with ligase enzymes, then position the CTX gene in the DNA, and then join the DNA by restriction enzymes
 - B. first open the bacterial DNA with restriction enzymes, then position the CTX gene in the DNA, and then join the DNA by ligase enzymes
 - C. first position the CTX gene in the DNA, then open the DNA with ligase enzymes, and then join the DNA by restriction enzymes
 - D. first position the CTX gene in the DNA, then open the DNA with restriction enzymes, and then join the DNA by ligase enzymes
39. The overall effects of cholera toxin are opposite to the physiological effects of which of the following hormones?
- A. Oxytocin
 - B. Thyroxine
 - C. Aldosterone
 - D. Epinephrine

Use the following information to answer the next two questions.

Some people have condemned the use of food preservatives because they may cause cancer. A researcher has found contradictory evidence that suggests that two widely used food preservatives actually increase levels of natural cancer-fighting agents in laboratory animals. The preservatives BHA and BHT increase the activity of a gene that controls the production of an enzyme. This enzyme helps destroy cancer-causing substances (carcinogens) before they trigger the development of tumours.

—from *Pearson et al*, 1983

40. The most **direct** relationship between a gene and an enzyme is that
- A. an enzyme causes a gene to destroy carcinogens
 - B. the sequence of nucleotides in a gene determines the structure of an enzyme
 - C. each gene contains the code needed to construct many different types of enzymes
 - D. the sequence of amino acids in an enzyme is unrelated to nucleotide sequence in a gene

Use the following additional information to answer the next question.

Some Events that Occur Following BHA or BHT Exposure

- 1 The polypeptide folds into an enzyme shape.
- 2 tRNAs transport amino acids to the ribosomes.
- 3 A polypeptide is released from the ribosomes.
- 4 mRNA leaves the nucleus and attaches to ribosomes in the cytoplasm.

Numerical Response

5. The sequence of events that results in the production of the cancer-fighting enzyme is _____, _____, _____, and _____.

(Record your **four-digit answer** in the numerical-response section on the answer sheet.)

Use the following information to answer the next question.

The Amish are a group of people who rarely marry outside of their community. In one group of Amish in Ohio, the incidence of cystic fibrosis was 19 in 10 816 live births. A second group of Amish in Ohio had no affected individuals in 4 448 live births. No members of either group are related. These data illustrate what population geneticists refer to as the “founder effect.”

—from *Klinger, 1983*

41. The “founder effect” seems to occur when
- A. the environment favours one population over another population
 - B. a non-representative subpopulation forms the basis for an isolated population
 - C. individuals from one population move into and become part of a second population
 - D. two similar populations exist in the same community without being reduced in number

Use the following information to answer the next question.

The fathead minnow is a small fish common in Alberta waters and is used as a food source by many different predators. When injured, some minnows secrete a chemical (called schreckstoff) that both attracts predators and causes other minnows to huddle in large groups. Approaching predators tend to be distracted by the mass of minnows and by each other. Often, the injured minnow can escape.

—from *Gonick, 1996*

42. The frequency of the gene that controls the production of schreckstoff by minnows is likely
- A. to increase in the gene pool of the population
 - B. to decrease in the gene pool of the population
 - C. to stay the same in the gene pool of the population because natural selection is occurring
 - D. to stay the same in the gene pool of the population because natural selection is not occurring

Use the following information to answer the next question.

In winter, snowshoe hares found in Jasper National Park create pathways in the snow between feeding and resting sites. These travel lanes are then used by porcupines, making the porcupines' movement through deep snow easier.

43. What relationship exists between the snowshoe hare and the porcupine?
- A. Mutualism
 - B. Predator–prey
 - C. Commensalism
 - D. Intraspecific competition
-

Use the following information to answer the next question.

In areas where moose and caribou share habitat, they are both preyed upon by wolves. The population cycle of the moose is affected by the presence of a second prey species, the caribou.

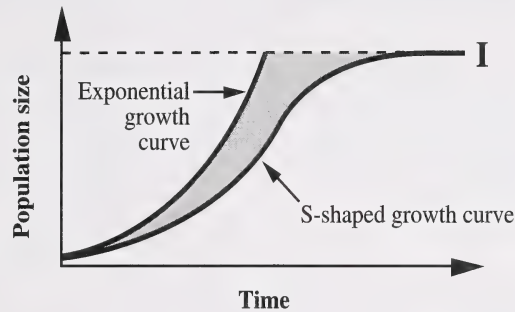
—from *Mech*, 1996

44. A reasonable prediction based on these predator–prey relationships is that
- A. predator species would not show population changes caused by density-dependent factors
 - B. low numbers of caribou would cause wolf starvation if the moose population was also low
 - C. wolf and prey populations would decline as the same diseases spread through the three populations
 - D. an area would have the same carrying capacity for moose as it has for caribou, even though each species has different food preferences

Use the following information to answer the next six questions.

A group of ecologists have studied the Jasper National Park animal populations and gathered data related to the growth of these populations.

J- and S-shaped Growth Curves of Theoretical Populations



—from Levine and Miller, 1991

45. Ecological data gathered over a 20-year period indicate that the elk population fluctuates around the level marked **I** on the graph. The biotic factors that keep this population stabilized are
- A. density dependent
 - B. density independent
 - C. independent of natality and mortality
 - D. independent of emigration and immigration
46. The level marked **I** on the graph represents the effect of factors such as climate, nutrients, soils, and water on the size of the elk population. A term to describe this section of the growth curve is
- A. lag phase
 - B. biotic potential
 - C. carrying capacity
 - D. climax community

Use the following additional information to answer the next two questions.

Data generated by ecologists working in Jasper National Park are used by park planners. Identifying a population as *r*-selected or K-selected may aid in wildlife management. Populations of caribou, elk, and wolves have been studied extensively.

Population Characteristic	Population Descriptors
Offspring Number	1 Few offspring 2 Large numbers of offspring
Body Size	3 Small in size 4 Large in size
Reproductive Maturity	5 Early reproductive maturity 6 Delayed reproductive maturity
Lifespan	7 Long lifespan 8 Short lifespan

Numerical Response

- 6.** Identify the population descriptor, as numbered above, that **best** matches each of the population characteristics below for a K-selected population such as the caribou or elk.

Population Descriptor: Population Characteristic:	Offspring Number	Body Size	Reproductive Maturity	Lifespan
------------------------------------------------------	---------------------	-----------	--------------------------	----------

(Record your **four-digit answer** in the numerical-response section on the answer sheet.)

Use the following additional information to answer the next question.

Predator–Prey Relationships				
Location	Animal 1	Animal 2	Density of Predators (number per 100 km ²)	Number of Prey
Jasper National Park	Wolf	Elk	0.6	1 200
Northwest Territories	Wolf	Caribou	0.3	500 000

Numerical Response

- 7.** The size of the wolf population in an area of 6000 km² of the Northwest Territories is calculated to be _____ wolves.

(Record your **answer as a whole number** in the numerical-response section on the answer sheet.)

Use the following additional information to answer the next two questions.

Many elk live in and around an 80 km² area that includes the Jasper town site.

47. If a disease were to kill 90% of these elk (an epidemic), what would be the likely consequence?
- A. The genetic variability in the population would decrease.
 - B. The population's resistance to all diseases would increase.
 - C. The mutation rate in genes for disease resistance would increase.
 - D. The population's gene frequencies would return to pre-epidemic values through genetic drift.
48. The elk population of this area at the beginning of a study year was 500. If there were 35 births and 5 deaths throughout the year, what was the per capita growth rate for the elk population during that year?
- A. 0.03
 - B. 0.06
 - C. 6
 - D. 30



Elk

—from *Alberta Recreation, Parks and Wildlife*

Use the following information to answer the next question.

The following table describes characteristics of communities.

A Possible location	B Community present	C Number of species
1 in an area clear cut by logging	1 pioneer	1 increase
2 on land bared by a forest fire	2 climax	2 decrease
3 on land released from a retreating glacier		

Numerical Response

- 8.** Use the numbered phrases or words from columns **A**, **B**, and **C** above to complete the statements below.

Primary succession would occur **A**, where the first organisms present are called a **B** community. During the first 20 years in the development of a community, the number of species would be expected to **C**.

Answer:

Letter: **A** **B** **C**

(Record your **three-digit answer** in the numerical-response section on the answer sheet.)

Use the following information to answer the next question.

Scientists are working hard to learn about causes of cancers. It is known that in general terms, cancer-causing agents produce mutations in a variety of genes that control cell reproduction.

Cancer can be caused by organisms. For example, when some viruses infect a human cell, the viral DNA may insert itself randomly into the DNA of human cells.

Of all the cancer-causing agents to which humans are commonly exposed, tobacco smoke appears to have caused the greatest harm. It is directly responsible for 30% of all cancer deaths in North America. Heavy smoking increases the likelihood of getting lung cancer by 2 000%. Passive (second-hand) smoke is less likely to cause cancer. It is about as harmful as all other forms of air pollution.

—from *Trichopoulos, Li, and Hunter, 1996*

Written Response – 15%

Staple your word-processed response for **this** question to this page.

- 1.**
 - a. A reasonable question for a researcher to ask would be “What percentage of smokers will die from cancer caused by tobacco smoke?” Assume that in a study to answer this question, you gather two groups of subjects and observe them over a long period of time.
 - i. Identify the manipulated variable and the responding variable for your study. **(2 marks)**
 - ii. Identify two variables that you would be unable to control, and explain why these variables would influence the conclusions of your study. **(3 marks)**

- b. Hypothesize how viral infection of human cells may lead to cancer. **(2 marks)**

Use the following additional information to answer the next part of the question.

Four percent of all cancer deaths can be linked to the reproductive history of a woman. Researchers have discovered that if a woman begins to menstruate at an early age and experiences late menopause, she is more likely to develop cancer in her reproductive organs. If a woman has several children and gave birth to them at a younger age, she is less likely to develop cancer of the ovary, breast, or endometrium.

—from *Trichopoulos, Li, and Hunter, 1996*

- c. i. Identify a social or economic change in Canadian society over the past few decades that could have had an impact on the rate of cancer in women's reproductive systems. **(1 mark)**
- ii. Describe how this change could affect the frequency of cancer in the reproductive systems of women in the Canadian population. **(1 mark)**

Use the following additional information to answer the next three parts of the question.

Scientists have been learning about a mechanism called the “cell cycle clock” that collects information from outside the cell. This information influences the activities of molecules within the cell that determine whether or not a cell will undergo mitosis. Some molecules take the form of “go” signals, stimulating a cell to go through mitosis. Other molecules take the form of “stop” signals to ensure that the cell does not start cell division. For example, some cyclins and CDKs are molecules that act as “go” signals. If these are present in appropriate amounts, DNA replication will occur.

—from *Trichopoulos, Li, and Hunter, 1996*

- d. At which phase of the cell cycle do these cyclins and CDKs appear to operate?
(1 mark)
- e. Drug companies are working on developing a drug that blocks the activities of these cyclins and CDKs. Predict how such a drug could act at the molecular level to prevent cancer. (1 mark)
- f. A mutation could disrupt the production or activation of molecules that act as “stop” or “go” signals. Describe how such a disruption could lead to cancer.
(1 mark)

Use the following information to answer the next question.

Adrenoleukodystrophy (ALD) is a rare disease of the central nervous system. ALD is characterized by the accumulation of very-long-chain fatty acids in the white matter of the brain and in the adrenal glands. These fatty acids cause the myelin sheath on nerve fibres within white matter of the central nervous system to degenerate. Symptoms of this degeneration become more severe as more and more fatty acids accumulate. Symptoms start with tantrums and other behavioural problems; then motor function, speech, and hearing are impaired; and finally blindness, mental deterioration, and death occur. ALD also affects the endocrine system by causing adrenal gland degeneration. ALD can be partially diagnosed by abnormally high ACTH levels in the blood.

Hereditary diseases have diverse causes. For example, the disease mutation may be dominant or recessive, or the mutated gene may be present on the X chromosome or on an autosome. In some cases, similar diseases are caused by mutations in two different genes. One such case is ALD, where one gene is autosomal and the other is X-linked. In both forms of inheritance, the disease mutation is recessive. Scientists continue to research the causes of ALD. The X-linked recessive form of ALD can be diagnosed prenatally.

ALD has not been treated successfully; however, bone marrow transplants and a diet restricted in very-long-chain fatty acids have shown promise. One dietary substance, oleic acid (Lorenzo's oil), has been successful in normalizing levels of very-long-chain fatty acids in blood plasma. However, the results of clinical trials on ALD patients showed little improvement in symptoms, particularly in brain degeneration. Lorenzo's oil did produce positive clinical results when the treatment of patients began before neurologic symptoms were present.

—from *McKusick, et al, 1997*

Written Response – 15%

Staple your word-processed response for **this** question to this page.

2. Write a unified response that addresses the following aspects of adrenoleukodystrophy.

- **Explain** how the degeneration of the myelin sheaths on cells in the white matter of the central nervous system could result in any of the impaired brain functions of ALD patients. **Identify** one hormone secreted by the adrenal gland, and **describe** how a decrease in secretion of this hormone would affect the body.
- **Describe** one piece of evidence obtained from the analysis of a pedigree chart that could be used to determine whether the mode of inheritance of a human genetic disorder is X-linked or autosomal **and** one piece of evidence that could be used to determine whether it is recessive or dominant. **Construct** a pedigree of four generations that clearly illustrates **one** of the two types of inheritance of ALD. Clearly **label** where your pedigree shows evidence of X-linked recessive or autosomal recessive inheritance.
- **Describe** one procedure that could be used to collect fetal cells for genetic screening. **Describe** a benefit and a risk to the individual and/or to society of early diagnosis of disorders like ALD.

This image shows a full page of a handwriting practice worksheet. It consists of multiple rows of horizontal dashed lines spaced evenly down the page, providing a guide for letter height and placement. The background is plain white, and there are no other markings or text present.

*You have now completed the examination.
If you have time, you may wish to check your answers.*

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BIOLOGY DATA

Symbols

Symbol	Description
D_p	population density
N	numbers of individuals in a population
A	area, space, or volume occupied by a population
t	time
Δ	change
r	biotic potential OR maximum per capita population growth rate
K	carrying capacity
$\frac{\Delta N}{\Delta t}$	a change in population size during time interval
$>$	greater than, dominant over
$<$	less than, recessive to

Symbol	Description
σ	male
φ	female
n	chromosome number
B, b	alleles; upper case is dominant, lower case is recessive
I^A, I^B, i	alleles, human blood type (ABO)
P	parent generation
F_1, F_2	first, second filial (generation)
p	frequency of dominant allele
q	frequency of recessive allele

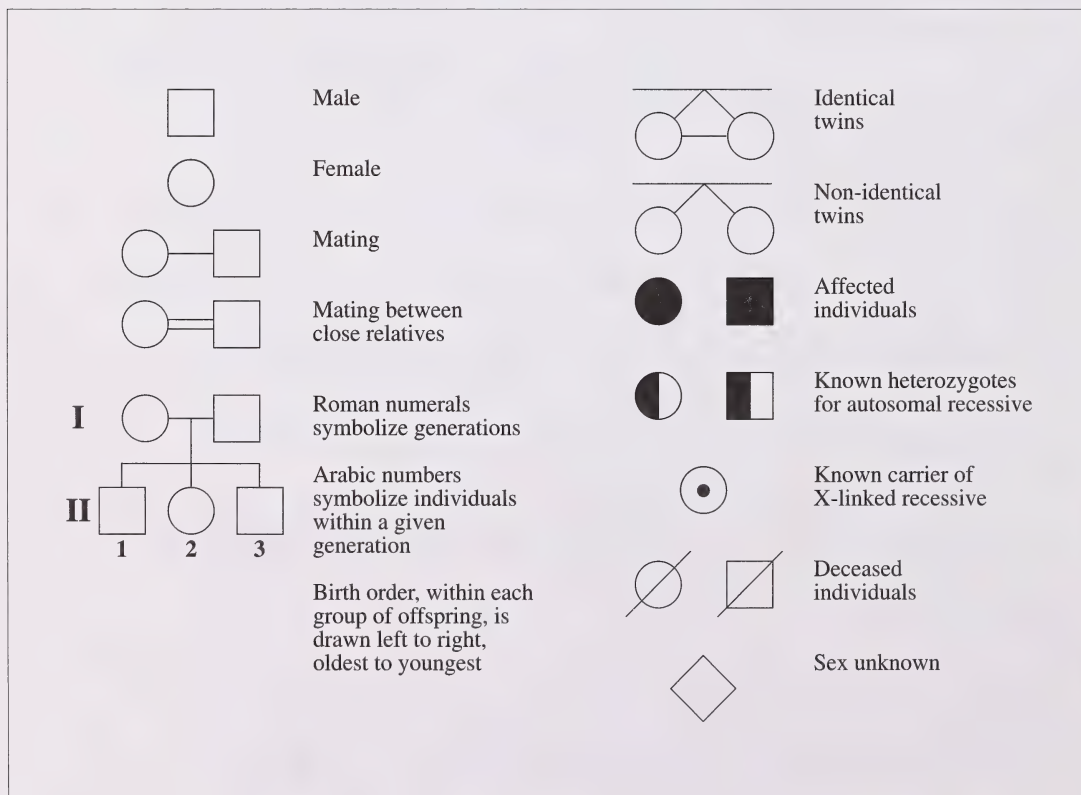
Equations

Subject	Equation
Hardy-Weinberg principle	$p^2 + 2pq + q^2 = 1$
Population density	$D_p = \frac{N}{A}$
Change in population size	$\Delta N = (\text{factors that increase pop.}) - (\text{factors that decrease pop.})$
Per capita growth rate (time will be determined by the question)	$cgr = \frac{\Delta N}{N}$
Growth rate	$\frac{\Delta N}{\Delta t} = rN$ $\frac{\Delta N}{\Delta t} = rN \frac{(K - N)}{K}$

Abbreviations for Some Hormones

Hormone	Abbreviation
Adrenocorticotropin hormone	ACTH
Antidiuretic hormone	ADH
Follicle stimulating hormone	FSH
Human chorionic gonadotropin	HCG
Luteinizing hormone	LH (formerly ICSH in males)
Parathyroid hormone	PTH
Prolactin	PRL
Somatotropin (human growth hormone or growth hormone)	STH (HGH or GH)
Thyroid stimulating hormone	TSH

Pedigree Symbols



Messenger RNA Codons and Their Corresponding Amino Acids

First Base	Second Base				Third Base
	U	C	A	G	
U	UUU phenylalanine	UCU serine	UAU tyrosine	UGU cysteine	U
	UUC phenylalanine	UCC serine	UAC tyrosine	UGC cysteine	C
	UUA leucine	UCA serine	UAA stop **	UGA stop **	A
	UUG leucine	UCG serine	UAG stop **	UGG tryptophan	G
C	CUU leucine	CCU proline	CAU histidine	CGU arginine	U
	CUC leucine	CCC proline	CAC histidine	CGC arginine	C
	CUA leucine	CCA proline	CAA glutamine	CGA arginine	A
	CUG leucine	CCG proline	CAG glutamine	CGG arginine	G
A	AUU isoleucine	ACU threonine	AAU asparagine	AGU serine	U
	AUC isoleucine	ACC threonine	AAC asparagine	AGC serine	C
	AUA isoleucine	ACA threonine	AAA lysine	AGA arginine	A
	AUG methionine*	ACG threonine	AAG lysine	AGG arginine	G
G	GUU valine	GCU alanine	GAU aspartate	GGU glycine	U
	GUC valine	GCC alanine	GAC aspartate	GGC glycine	C
	GUA valine	GCA alanine	GAA glutamate	GGA glycine	A
	GUG valine	GCG alanine	GAG glutamate	GGG glycine	G

* Note: AUG is an initiator codon and also codes for the amino acid methionine.

** Note: UAA, UAG, and UGA are terminator codons.

Information About Nitrogen Bases

Nitrogen Base	Classification	Abbreviation
Adenine	Purine	A
Guanine	Purine	G
Cytosine	Pyrimidine	C
Thymine	Pyrimidine	T
Uracil	Pyrimidine	U

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